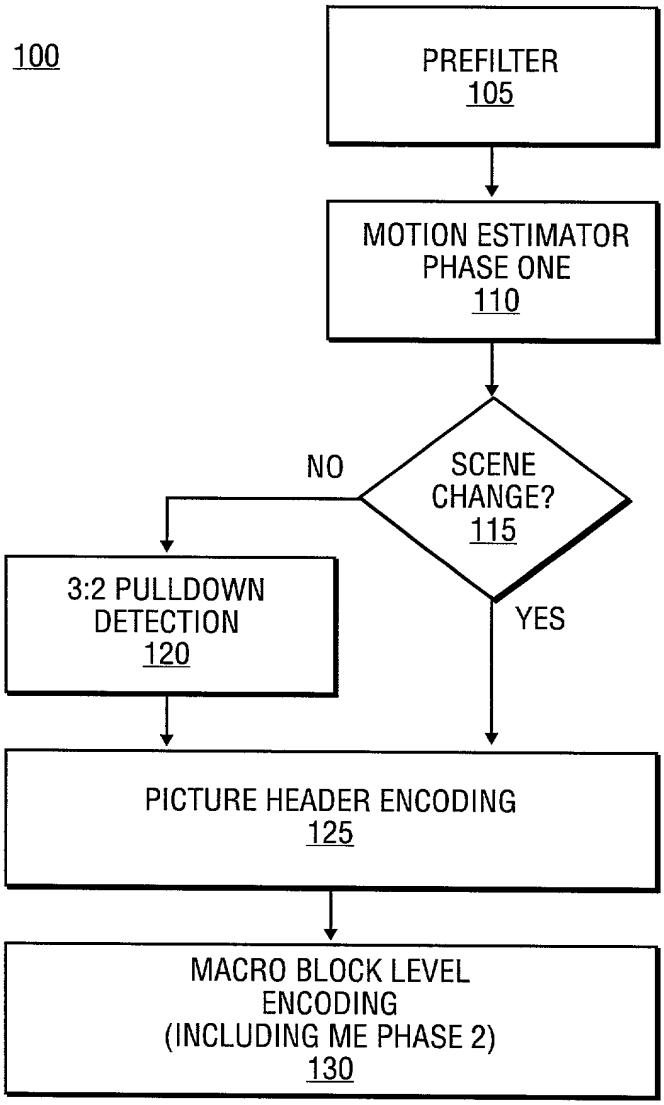
100
PREFILTER
105
MOTION ESTIMATOR
PHASE ONE
110
SCENE
CHANGE?
115
NO
YES
3:2 PULLDOWN
DETECTION
120
PICTURE HEADER ENCODING
125
MACRO BLOCK LEVEL
ENCODING
(INCLUDING ME PHASE 2)
130

FIG. 1

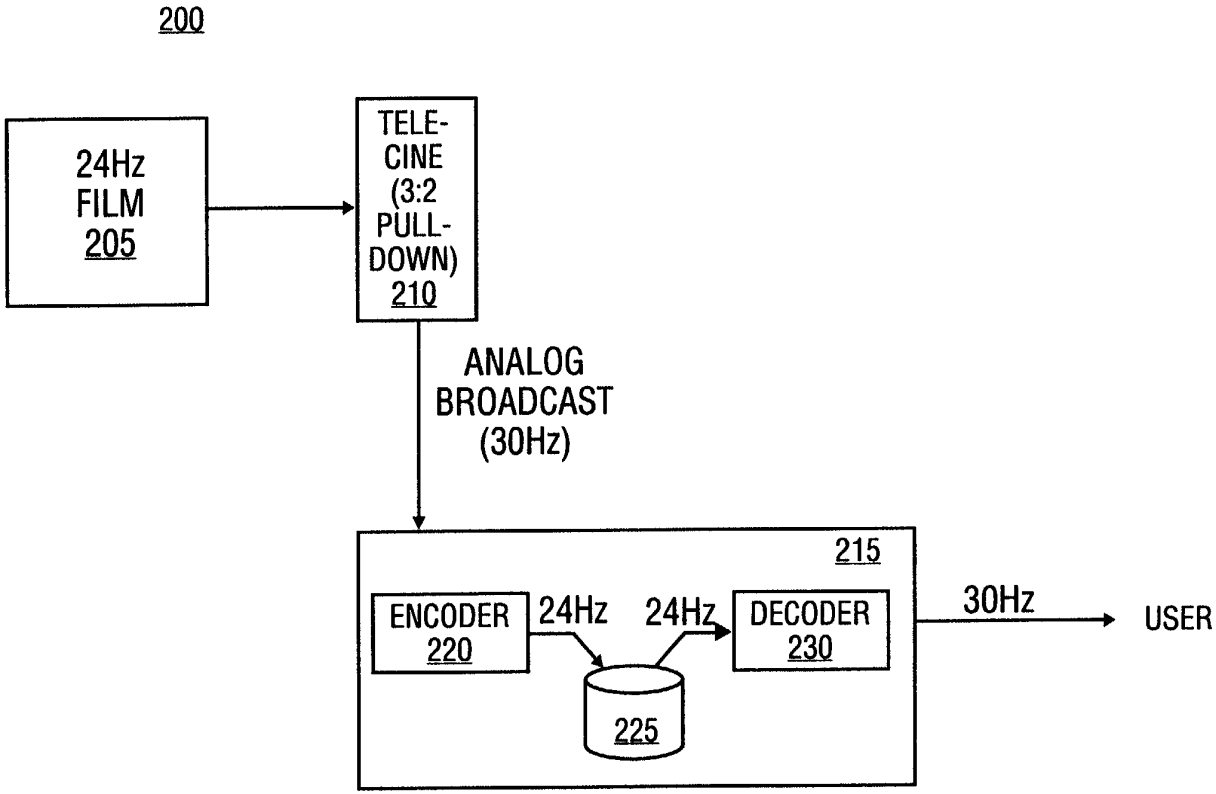

FIG. 2

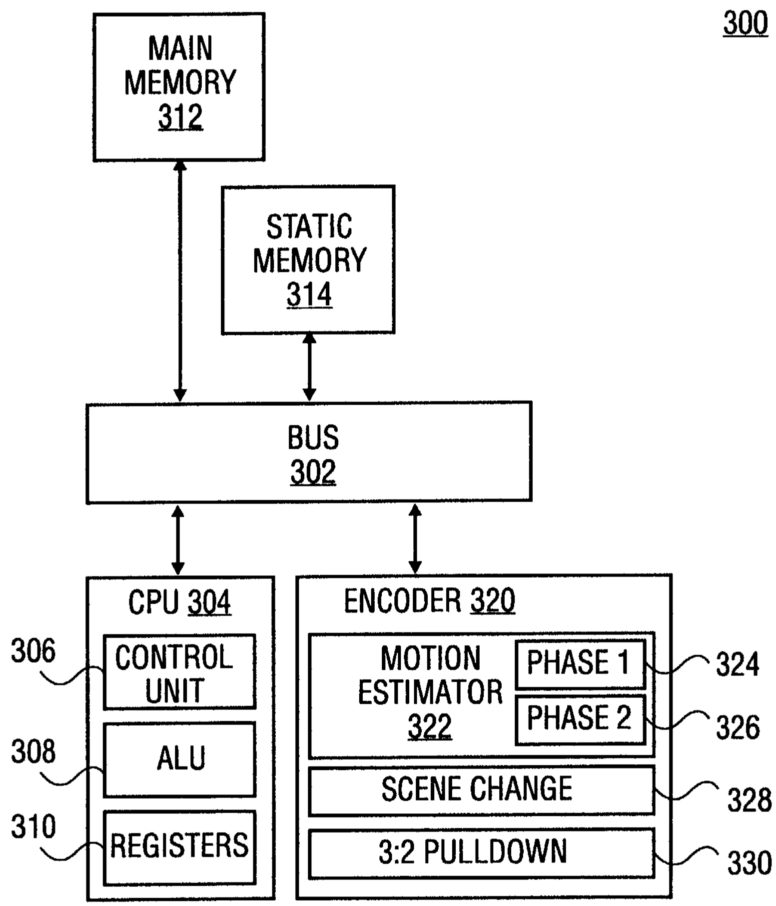
300
MAIN MEMORY 312
STATIC MEMORY 314
BUS 302
CPU 304
CONTROL UNIT
ALU
REGISTERS
306
308
310
ENCODER 320
MOTION ESTIMATOR 322
PHASE 1
PHASE 2
SCENE CHANGE
3:2 PULLDOWN
324
326
328
330

FIG. 3A

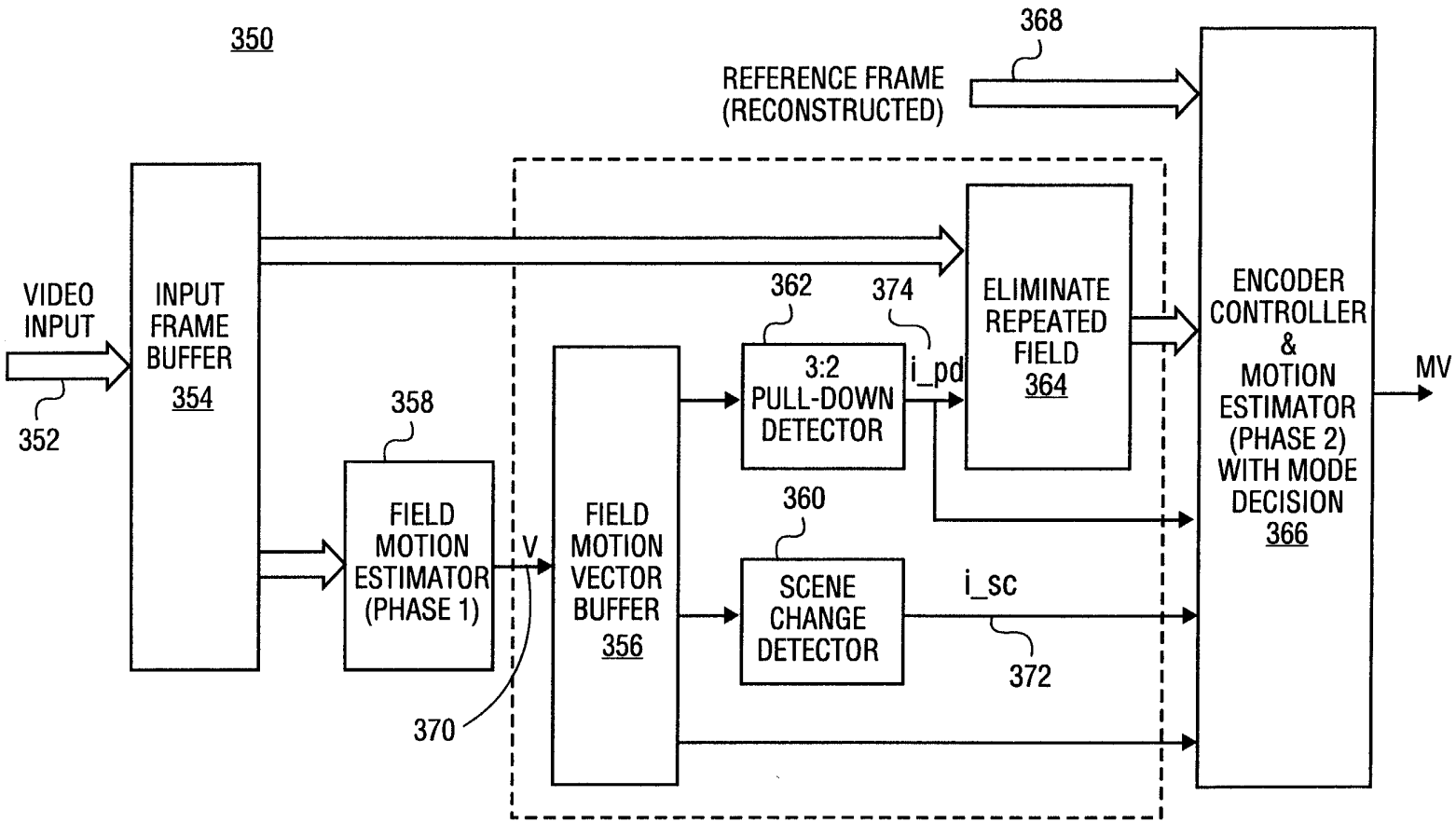
350
368
REFERENCE FRAME
(RECONSTRUCTED)
VIDEO
INPUT
352
INPUT
FRAME
BUFFER
354
358
FIELD
MOTION
ESTIMATOR
(PHASE 1)
V
370
FIELD
MOTION
VECTOR
BUFFER
356
362
374
3:2
PULL-DOWN
DETECTOR
i_pd
360
SCENE
CHANGE
DETECTOR
i_sc
372
ELIMINATE
REPEATED
FIELD
364
ENCODER
CONTROLLER
&
MOTION
ESTIMATOR
(PHASE 2)
WITH MODE
DECISION
366
MV

FIG. 3B

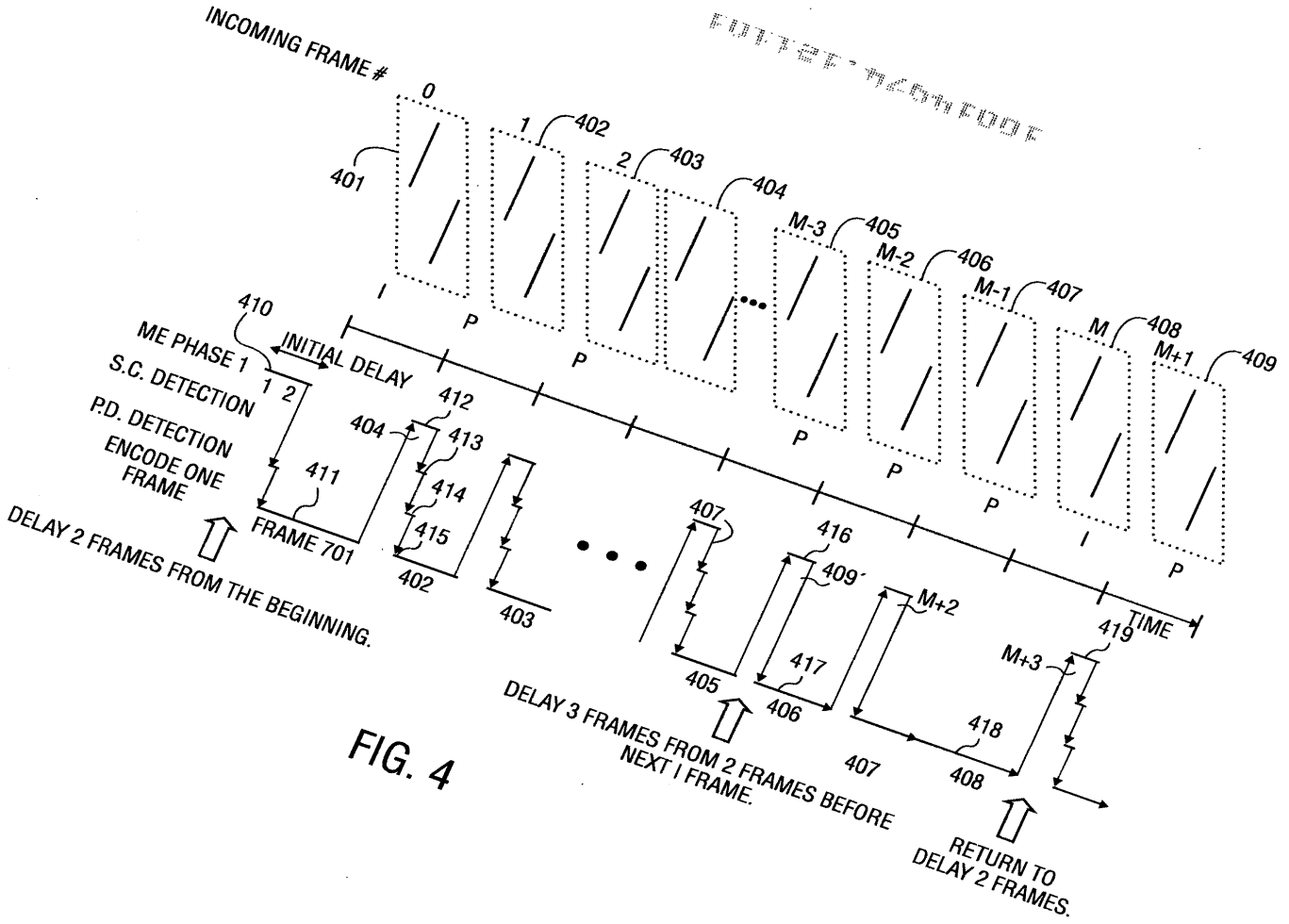
INCOMING FRAME #
0
1
2
M-3
M-2
M-1
M
M+1
401
402
403
404
405
406
407
408
409
I
P
410
INITIAL DELAY
ME PHASE 1
S.C. DETECTION
P.D. DETECTION
ENCODE ONE FRAME
1 2
411
FRAME 701
412
413
414
415
416
417
418
419
M+2
M+3
TIME
DELAY 2 FRAMES FROM THE BEGINNING.
DELAY 3 FRAMES FROM 2 FRAMES BEFORE NEXT I FRAME.
RETURN TO DELAY 2 FRAMES.

FIG. 4

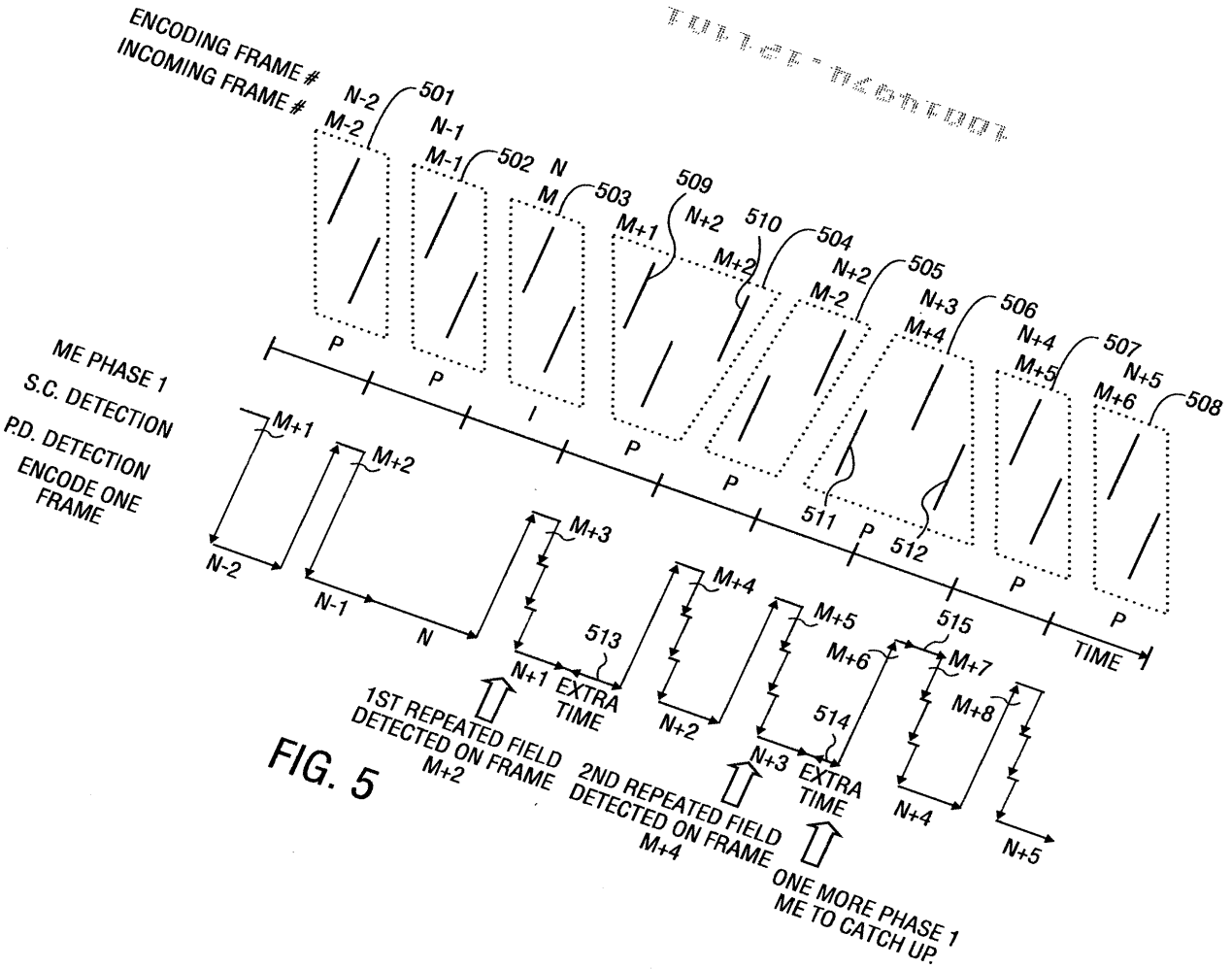
ENCODING FRAME #
INCOMING FRAME #
ME PHASE 1
S.C. DETECTION
P.D. DETECTION
ENCODE ONE FRAME
TIME
1ST REPEATED FIELD DETECTED ON FRAME M+2
2ND REPEATED FIELD DETECTED ON FRAME M+4
ONE MORE PHASE 1 ME TO CATCH UP.
EXTRA TIME
EXTRA TIME

FIG. 5

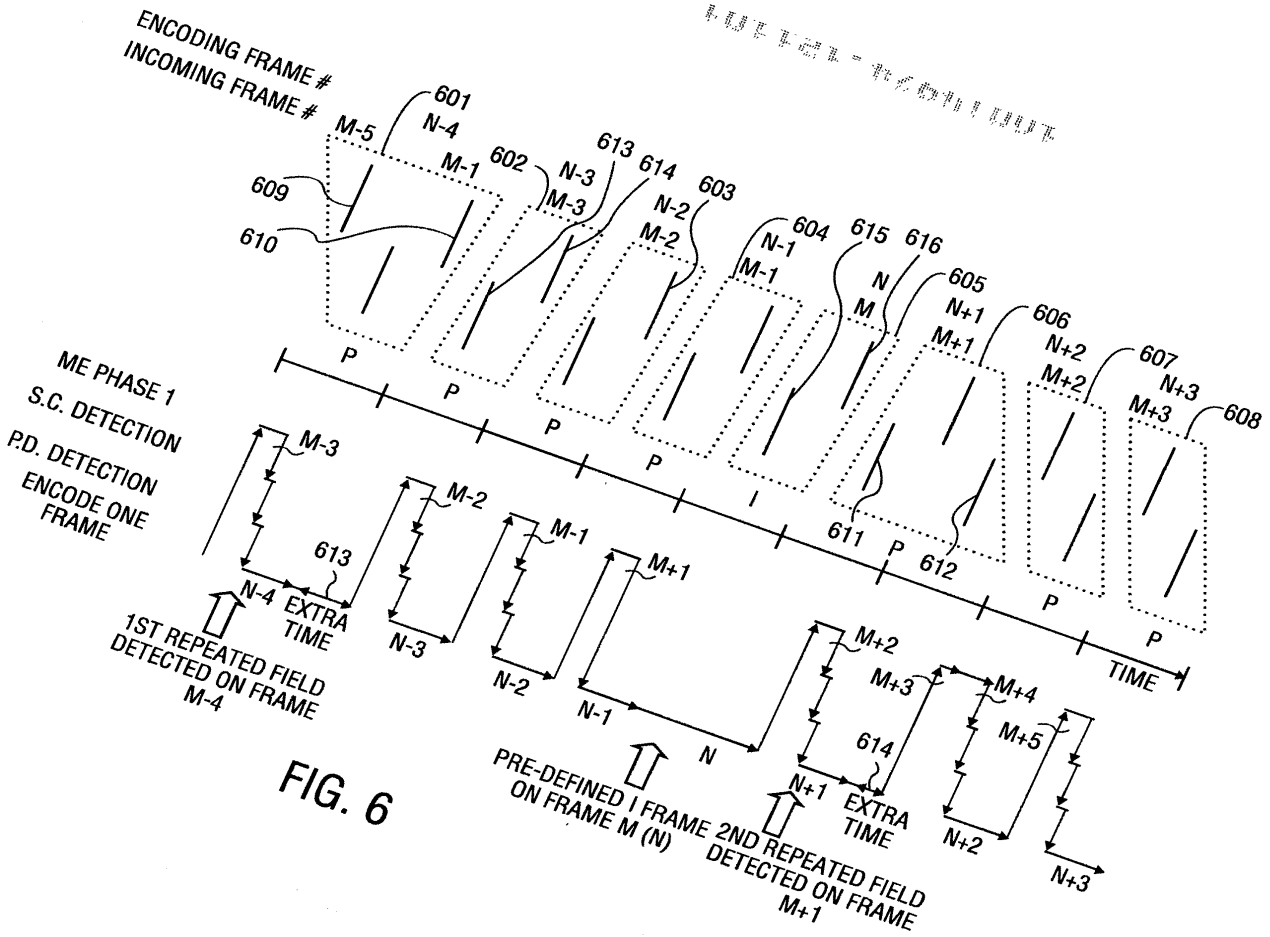
ENCODING FRAME #
INCOMING FRAME #
ME PHASE 1
S.C. DETECTION
P.D. DETECTION
ENCODE ONE FRAME
601
602
603
604
605
606
607
608
609
610
611
612
613
614
615
616
M-5
N-4
M-1
N-3
M-3
N-2
M-2
N-1
M-1
N
M
N+1
M+1
N+2
M+2
N+3
M+3
P
I
TIME
EXTRA TIME
1ST REPEATED FIELD DETECTED ON FRAME M-4
PRE-DEFINED I FRAME ON FRAME M (N)
2ND REPEATED FIELD DETECTED ON FRAME M+1
M+4
M+5
N+1
N+2
N+3

FIG. 6

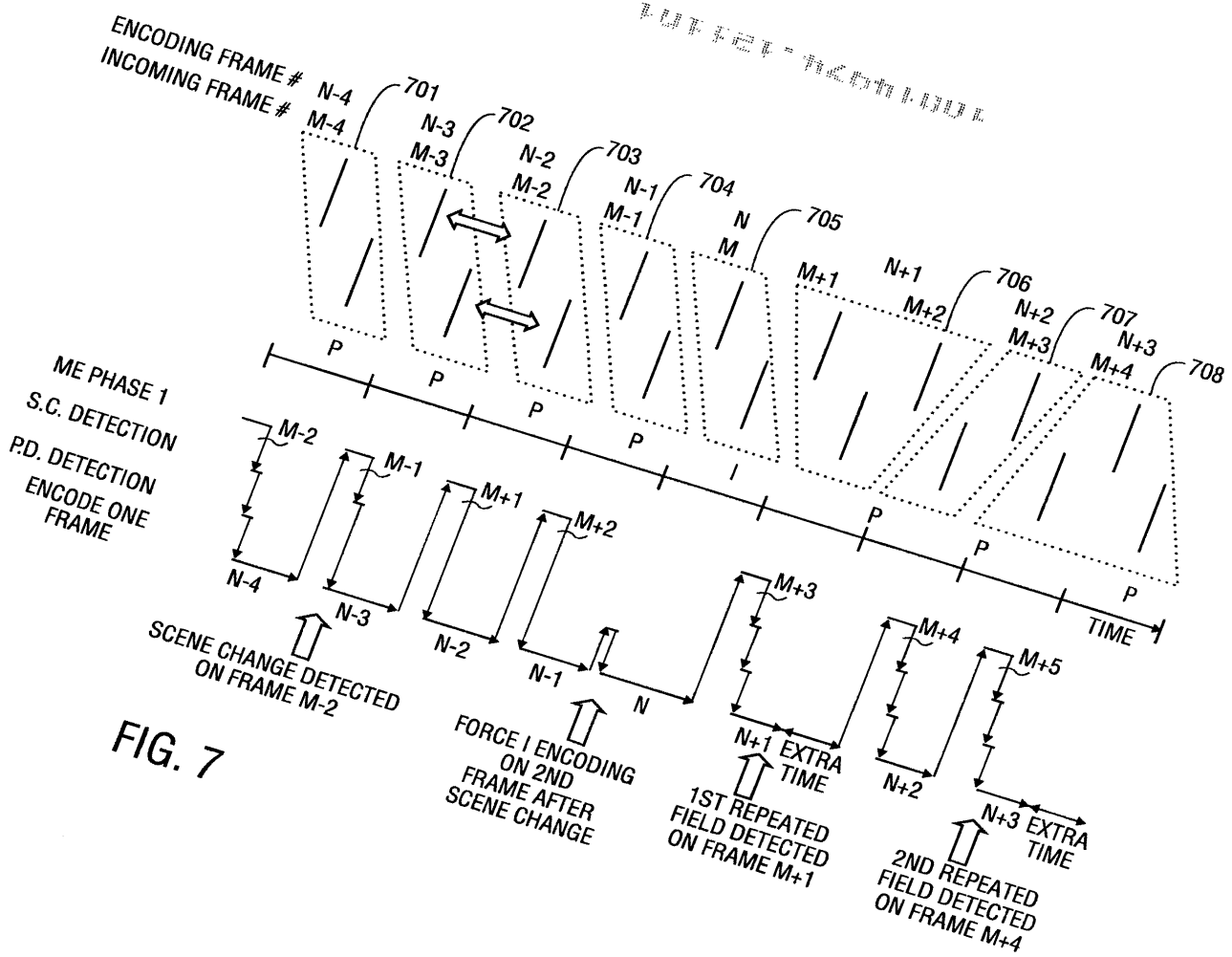
ENCODING FRAME #
INCOMING FRAME #
N-4
M-4
701
N-3
M-3
702
N-2
M-2
703
N-1
M-1
704
N
M
705
M+1
N+1
706
M+2
N+2
707
M+3
N+3
M+4
708
ME PHASE 1
S.C. DETECTION
P.D. DETECTION
ENCODE ONE FRAME
P
P
P
P
I
P
P
P
TIME
M-2
M-1
M+1
M+2
M+3
M+4
M+5
N-4
N-3
N-2
N-1
N
N+1
N+2
N+3
EXTRA TIME
EXTRA TIME
SCENE CHANGE DETECTED ON FRAME M-2
FORCE I ENCODING ON 2ND FRAME AFTER SCENE CHANGE
1ST REPEATED FIELD DETECTED ON FRAME M+1
2ND REPEATED FIELD DETECTED ON FRAME M+4

FIG. 7

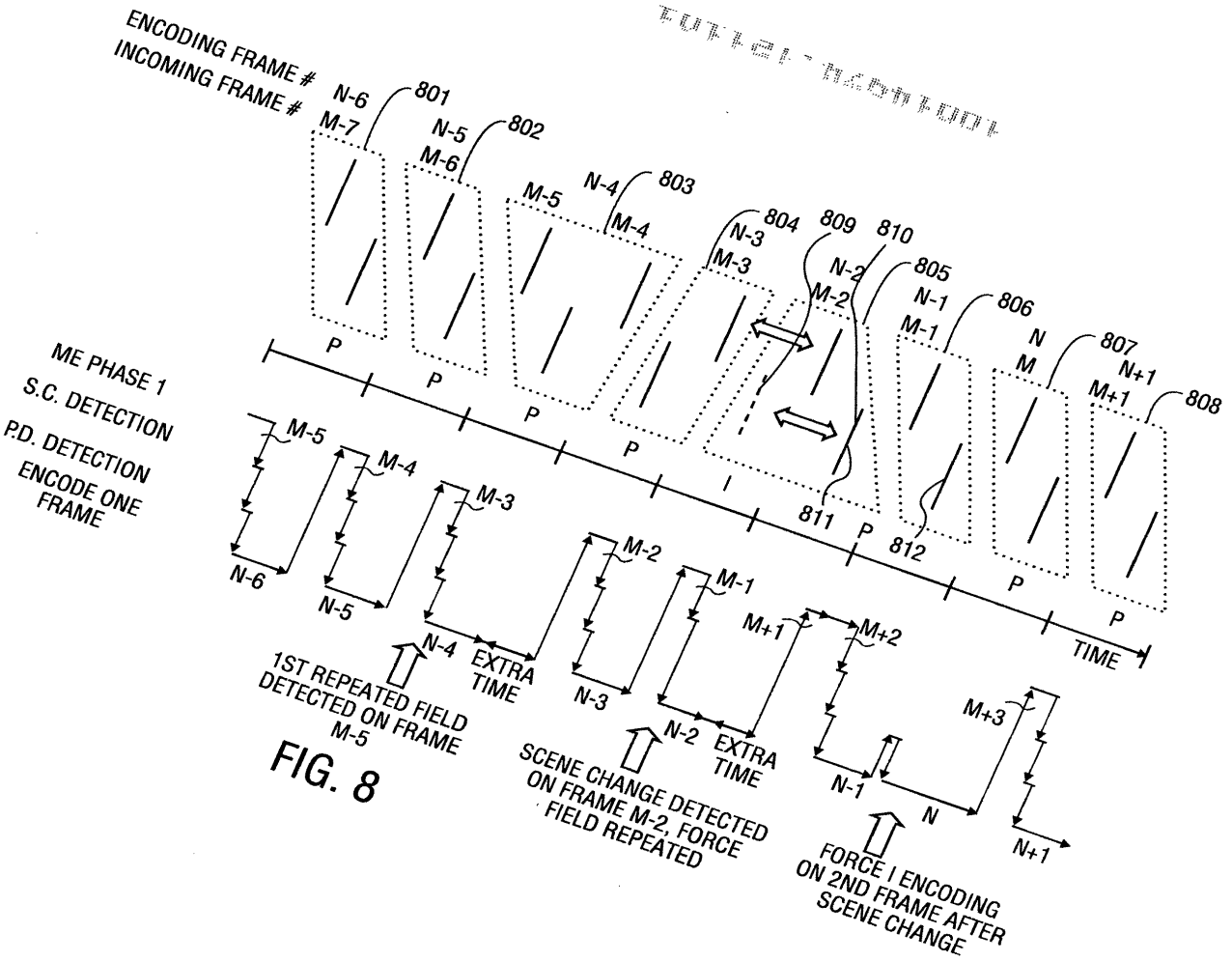
ENCODING FRAME #
INCOMING FRAME #
N-6
M-7
801
N-5
M-6
802
M-5
N-4
M-4
803
N-3
M-3
804
809
810
N-2
M-2
805
N-1
M-1
806
N
M
807
N+1
M+1
808
P
P
P
P
I
811
P
812
P
P
TIME
ME PHASE 1
S.C. DETECTION
P.D. DETECTION
ENCODE ONE FRAME
M-5
M-4
M-3
M-2
M-1
M+1
M+2
M+3
N-6
N-5
N-4
N-3
N-2
N-1
N
N+1
EXTRA TIME
EXTRA TIME
1ST REPEATED FIELD DETECTED ON FRAME M-5
SCENE CHANGE DETECTED ON FRAME M-2, FORCE FIELD REPEATED
FORCE I ENCODING ON 2ND FRAME AFTER SCENE CHANGE

FIG. 8

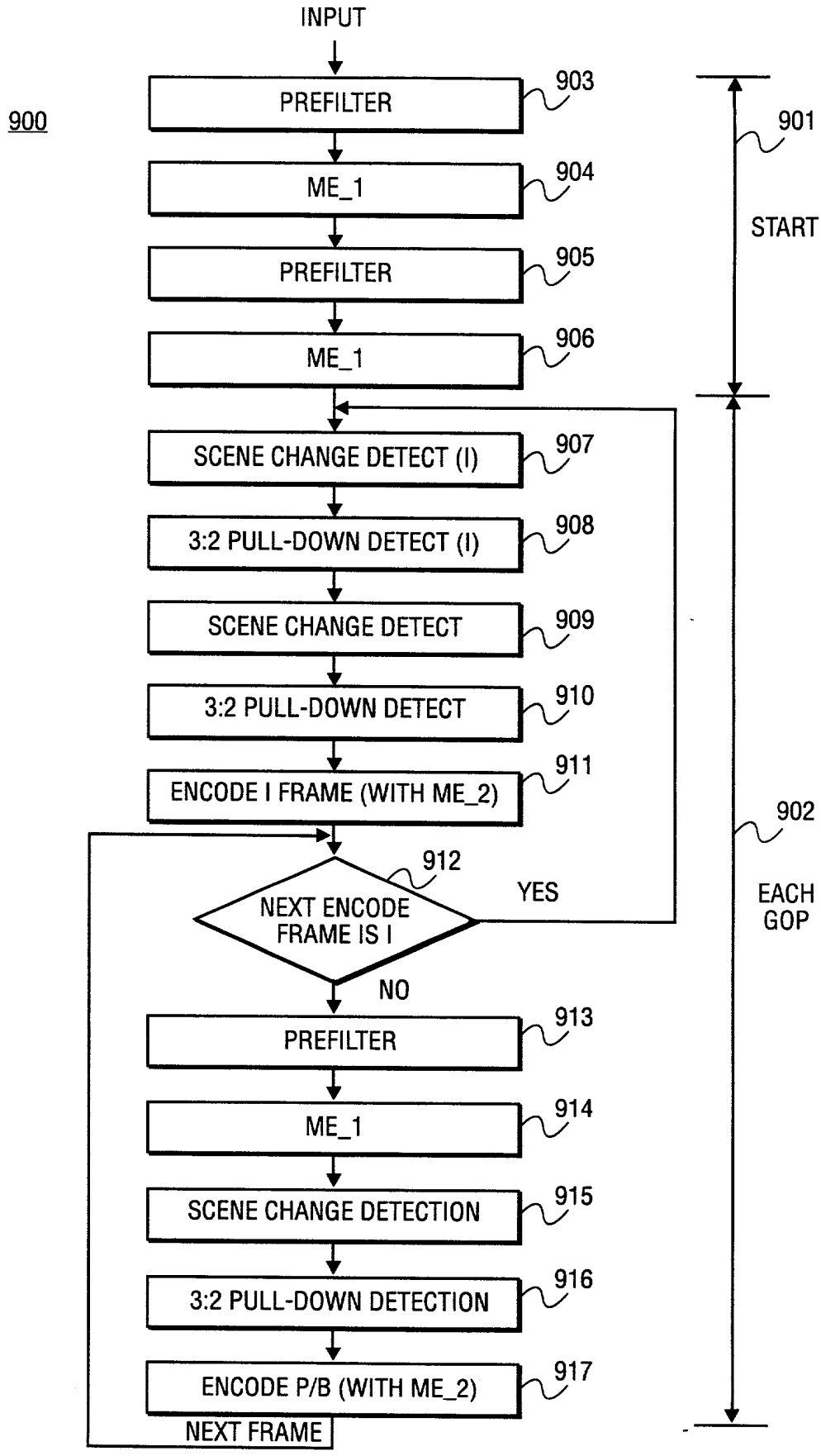
INPUT
900
PREFILTER
903
ME_1
904
PREFILTER
905
ME_1
906
901
START
SCENE CHANGE DETECT (I)
907
3:2 PULL-DOWN DETECT (I)
908
SCENE CHANGE DETECT
909
3:2 PULL-DOWN DETECT
910
ENCODE I FRAME (WITH ME_2)
911
902
912
NEXT ENCODE FRAME IS I
YES
EACH GOP
NO
PREFILTER
913
ME_1
914
SCENE CHANGE DETECTION
915
3:2 PULL-DOWN DETECTION
916
ENCODE P/B (WITH ME_2)
917
NEXT FRAME

FIG. 9

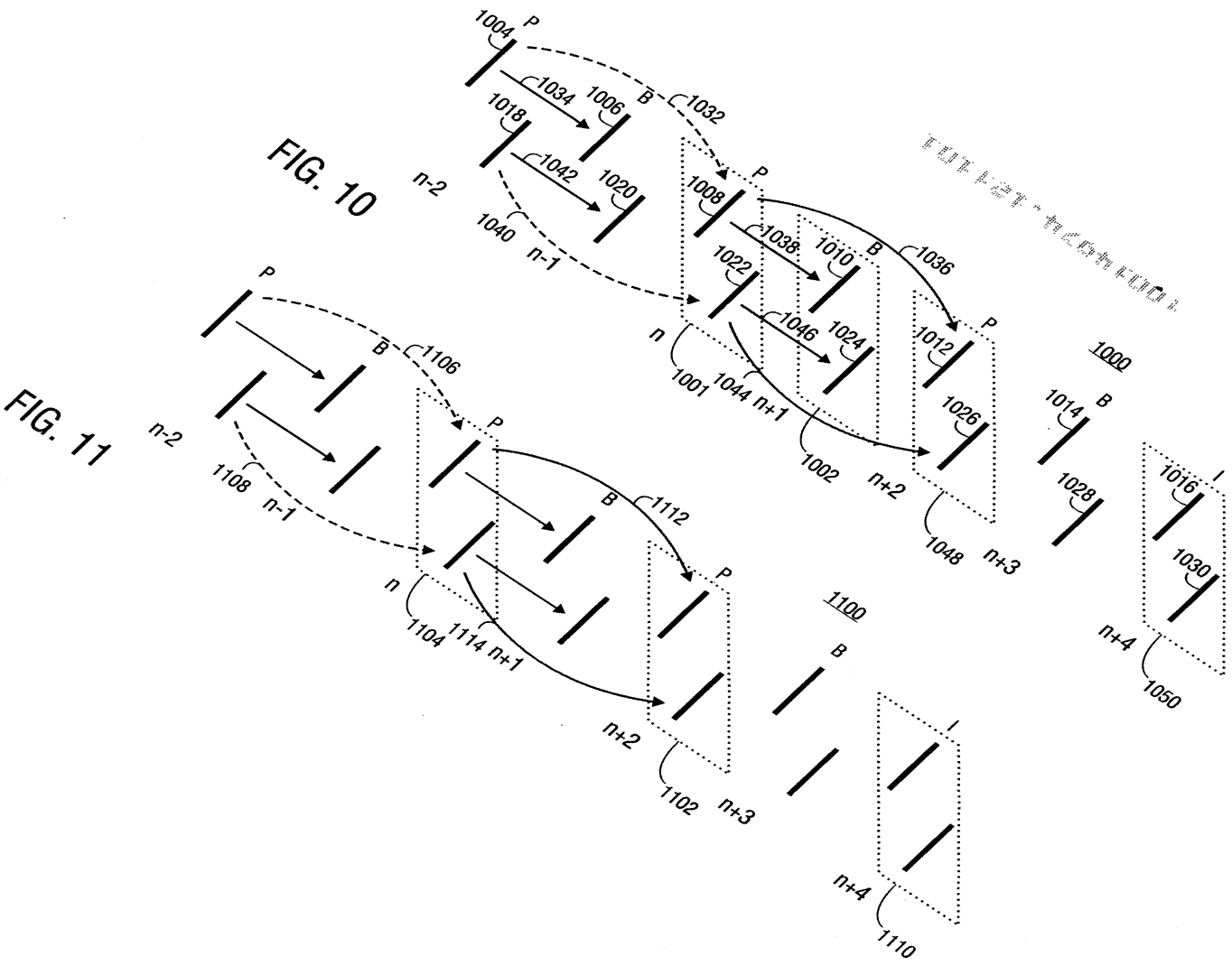
1004
P
1034
1006
B
1032
1018
1042
1020
1040
n-2
n-1
1008
P
1038
1010
B
1036
1022
1046
1024
1012
P
n
1001
1044
n+1
1002
n+2
1026
1000
1014
B
1048
n+3
1028
1016
1030
n+4
1050
1100
B
1110
n+4
1102
n+3
n+2
1104
n
1114
n+1
1112
P
1106
B
1108
n-1
n-2
P

FIG. 10

FIG. 11

P
B
P
n+i-2
n+i-1
n+i
n+i+1
1202
B
n+i+2
1204
I
n+i+3
1200
B
P
n+i+4

FIG. 12

P
B
P
n+i-3
n+i-2
n+i-1
n+i
1306
1304
B
P
n+i+1
1302
n+i+2
1300
B
I
n+i+3
1308

FIG. 13

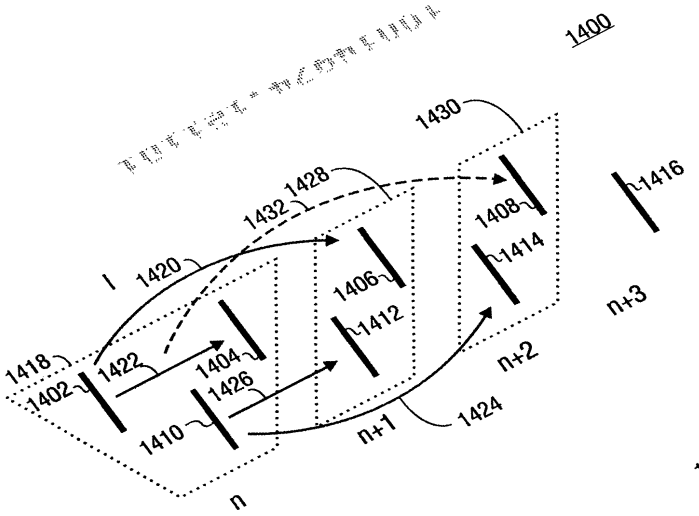
1400
1430
1428
1432
1408
1416
I
1420
1406
1414
1418
1422
1404
1412
1402
1426
1410
n+3
n+2
n+1
1424
n

FIG. 14

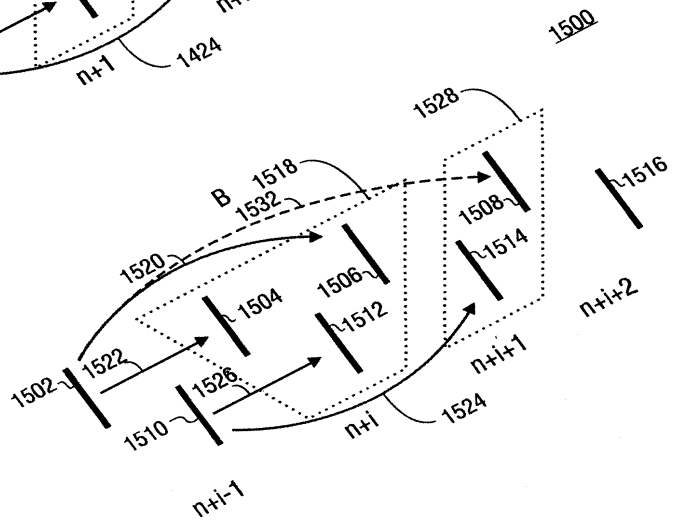
1500
1528
B
1518
1532
1516
1508
1520
1506
1514
1504
1512
1502
1522
1526
1510
n+i+2
n+i+1
n+i
1524
n+i-1

FIG. 15

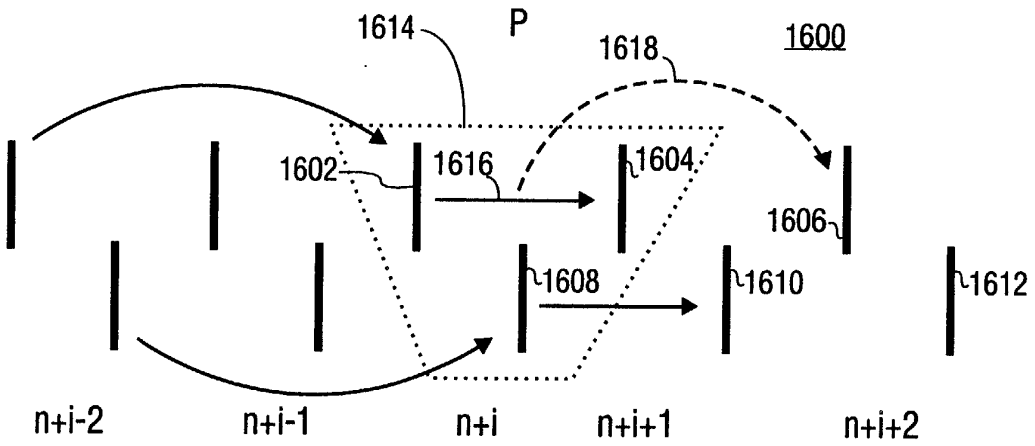
1614
P
1618
1600
1602
1616
1604
1606
1608
1610
1612
n+i-2
n+i-1
n+i
n+i+1
n+i+2

FIG. 16

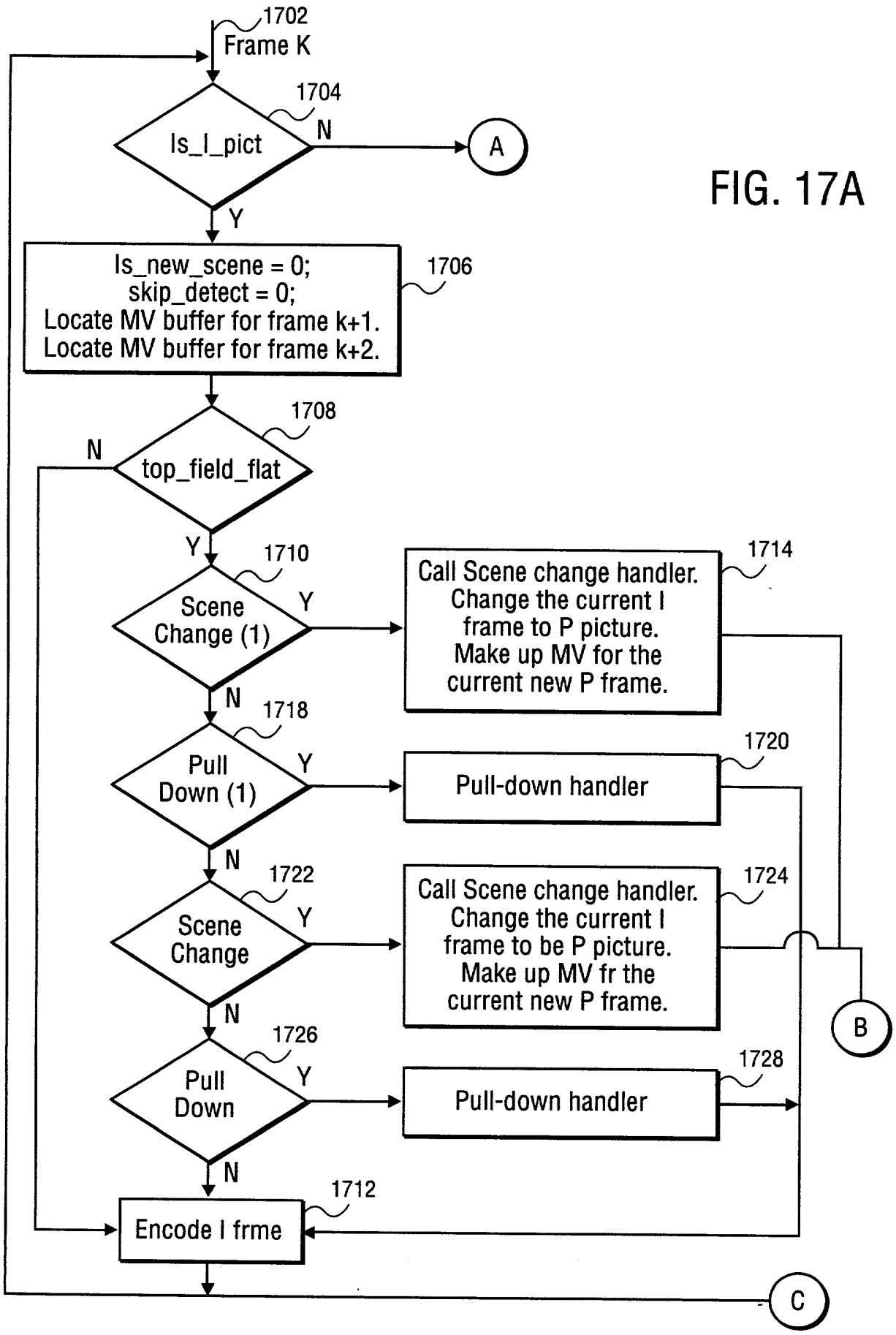
1702
Frame K
1704
Is_I_pict
N
A
Y
Is_new_scene = 0;
skip_detect = 0;
Locate MV buffer for frame k+1.
Locate MV buffer for frame k+2.
1706
1708
top_field_flat
N
Y
1710
Scene Change (1)
Y
1714
Call Scene change handler.
Change the current I frame to P picture.
Make up MV for the current new P frame.
N
1718
Pull Down (1)
Y
1720
Pull-down handler
N
1722
Scene Change
Y
1724
Call Scene change handler.
Change the current I frame to be P picture.
Make up MV fr the current new P frame.
N
1726
Pull Down
Y
1728
Pull-down handler
N
1712
Encode I frme
B
C

FIG. 17A

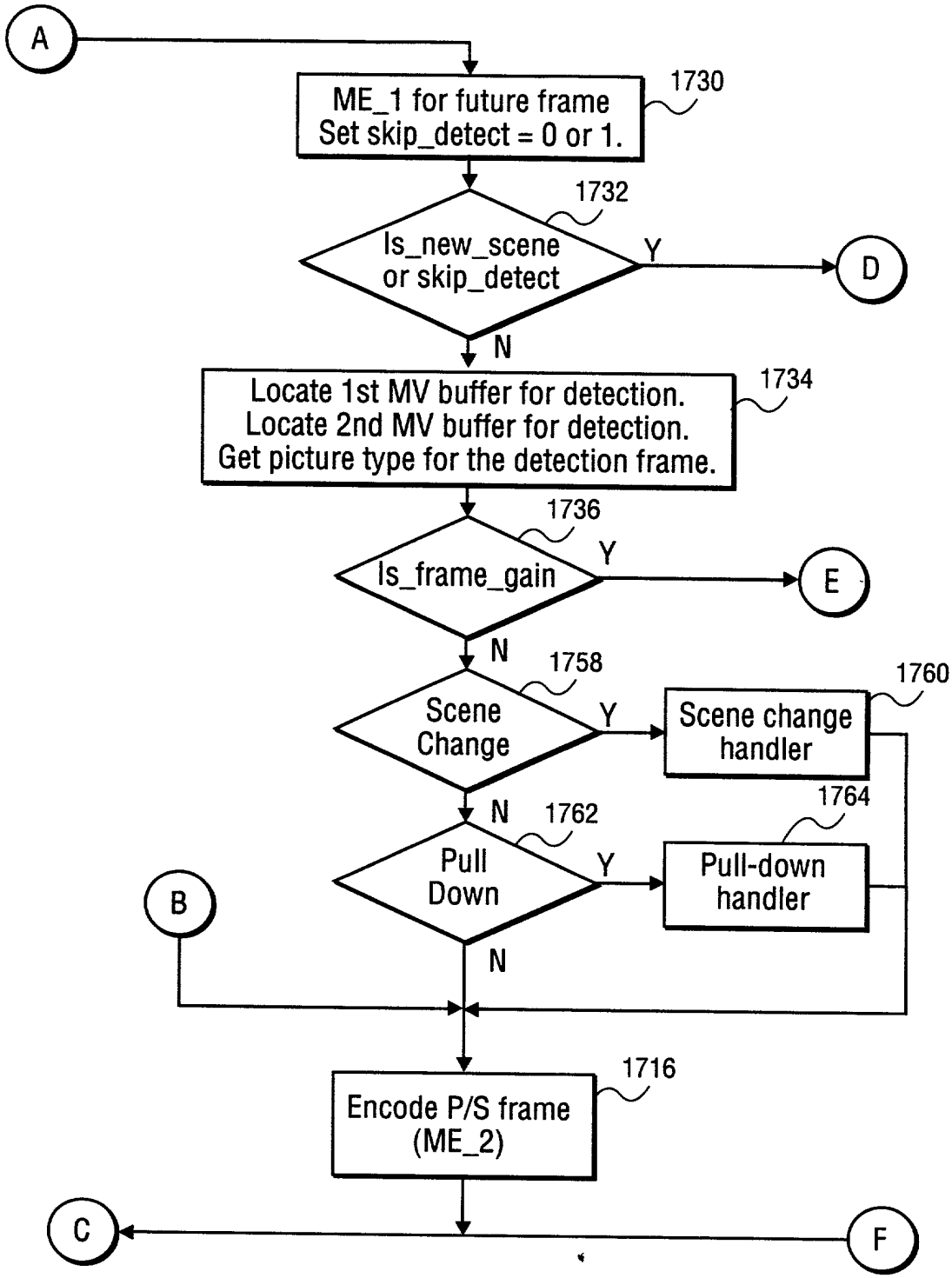
A
ME_1 for future frame
Set skip_detect = 0 or 1.
1730
1732
Is_new_scene
or skip_detect
Y
D
N
Locate 1st MV buffer for detection.
Locate 2nd MV buffer for detection.
Get picture type for the detection frame.
1734
1736
Is_frame_gain
Y
E
N
1758
Scene
Change
Y
Scene change
handler
1760
N
1762
Pull
Down
Y
Pull-down
handler
1764
B
N
Encode P/S frame
(ME_2)
1716
C
F

FIG. 17B

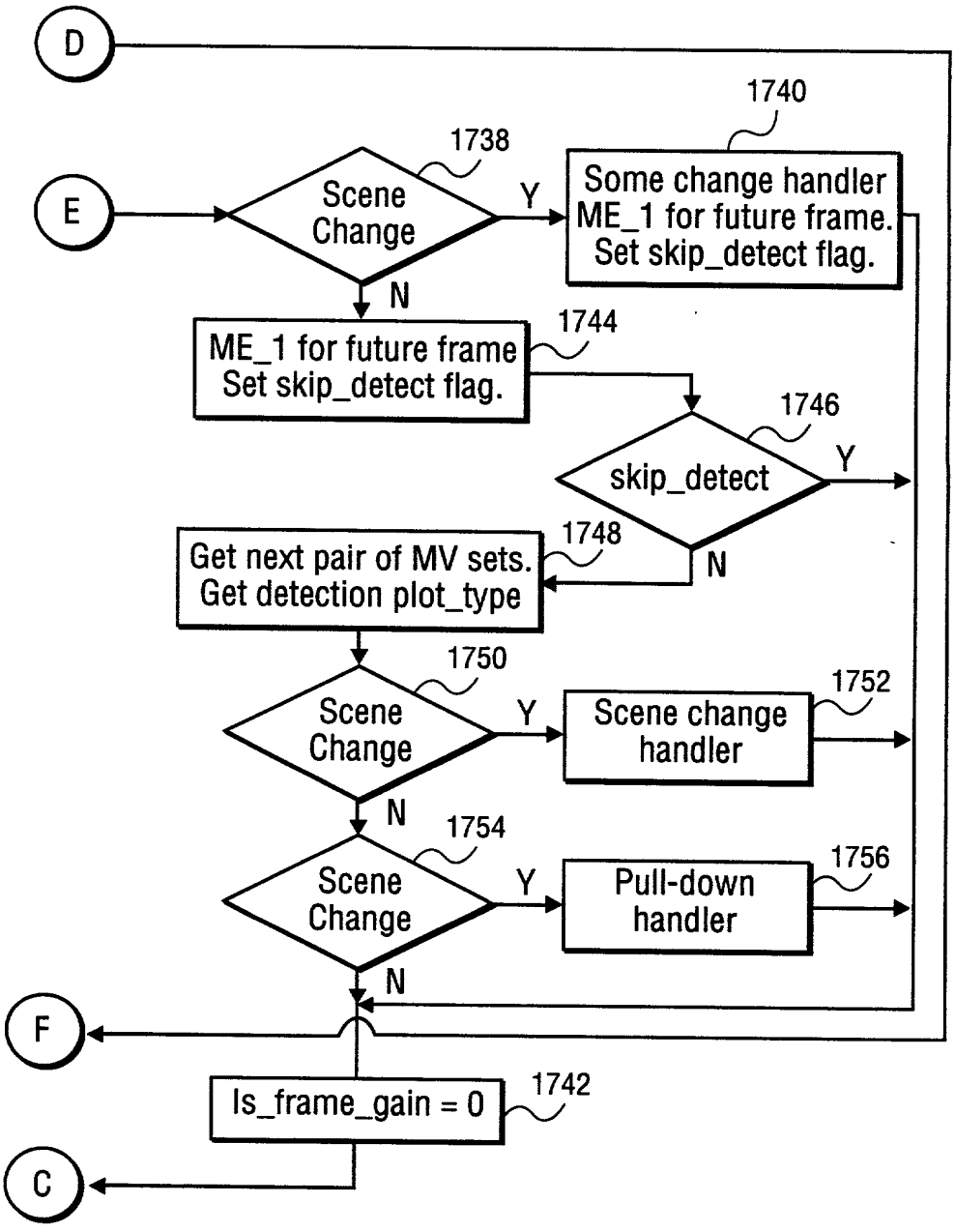
D
E
F
C
1738
Scene Change
Y
N
1740
Some change handler ME_1 for future frame. Set skip_detect flag.
ME_1 for future frame Set skip_detect flag.
1744
1746
skip_detect
Y
N
1748
Get next pair of MV sets. Get detection plot_type
1750
Scene Change
Y
N
1752
Scene change handler
1754
Scene Change
Y
N
1756
Pull-down handler
Is_frame_gain = 0
1742

FIG. 17C

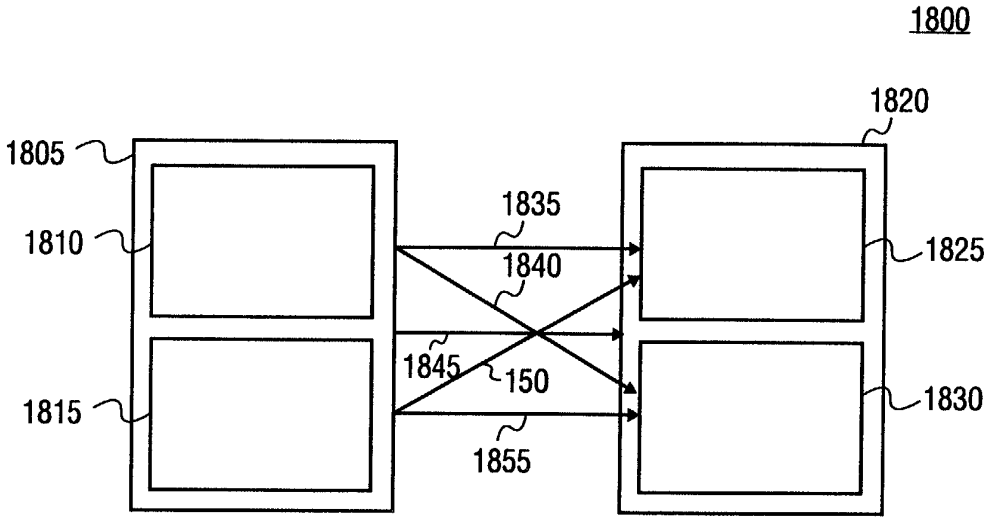

FIG. 18A

Top-field First

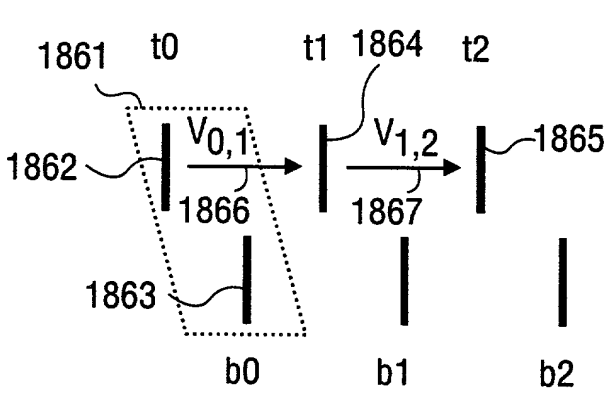

FIG. 18B

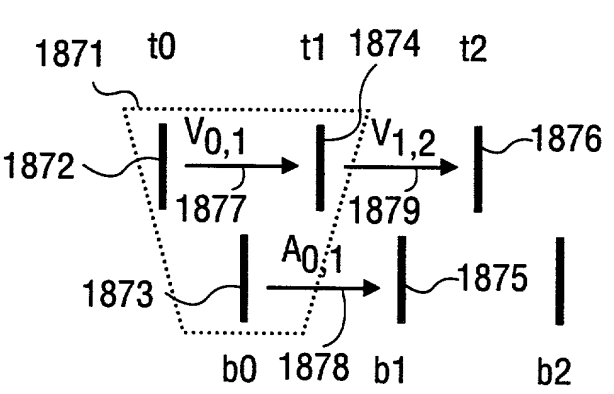

FIG. 18C

Bottom-field First

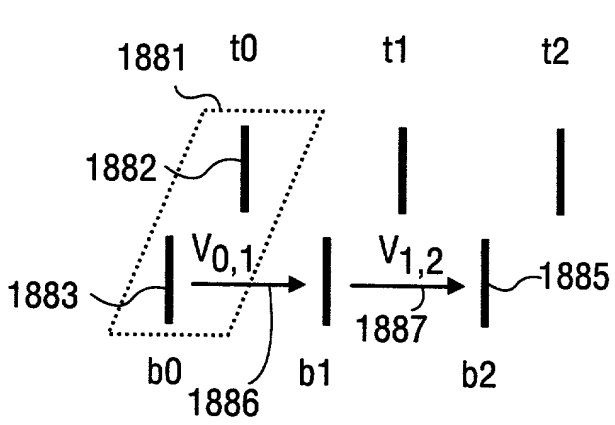

FIG. 18D

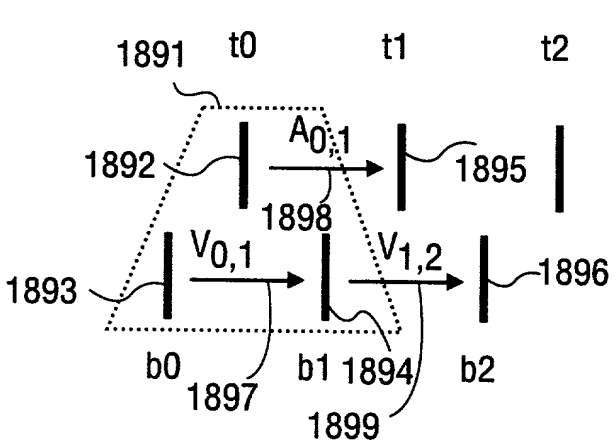

FIG. 18E

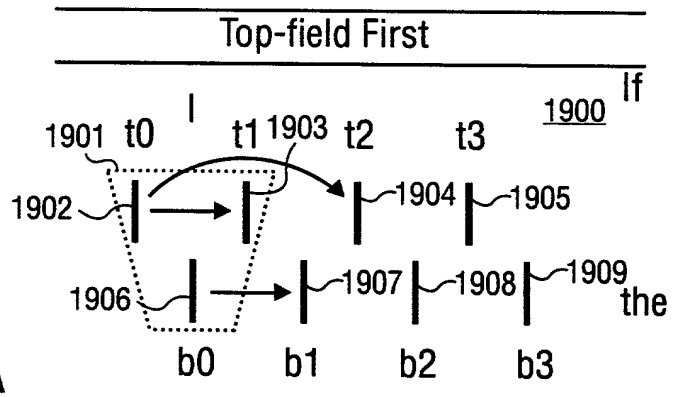

FIG. 19A

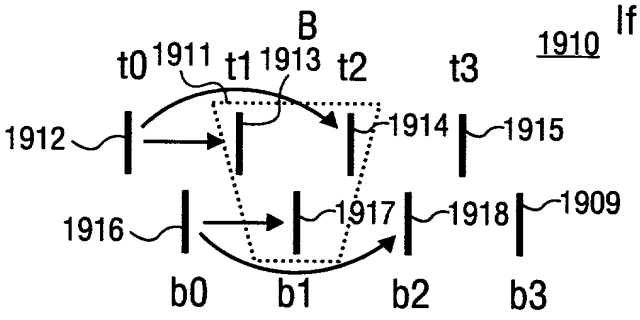

FIG. 19B

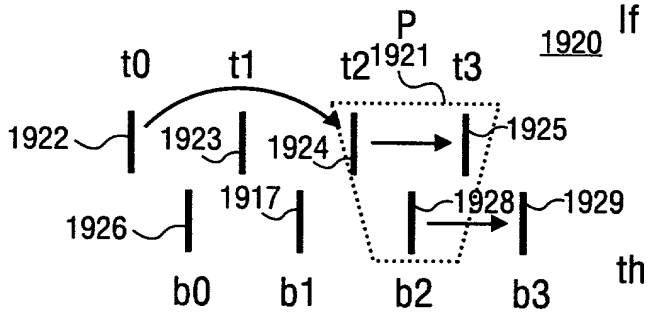

FIG. 19C

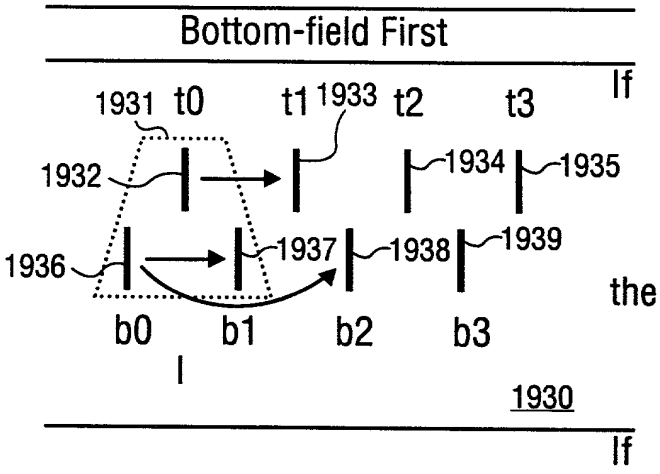

FIG. 19D

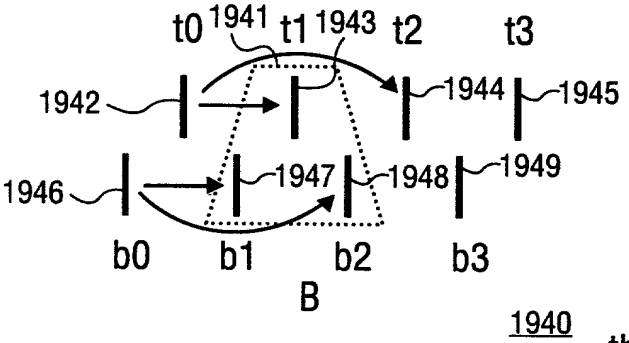

FIG. 19E

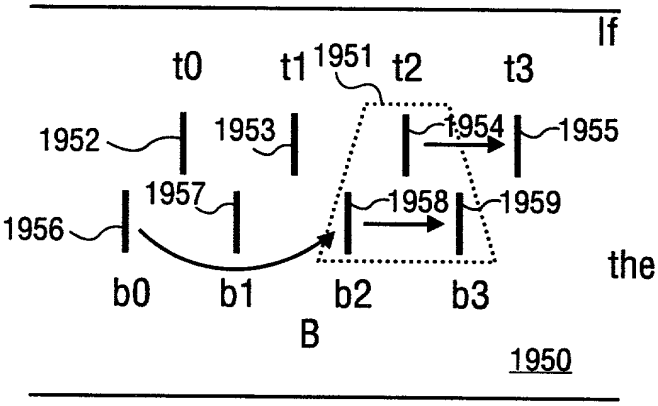

FIG. 19F

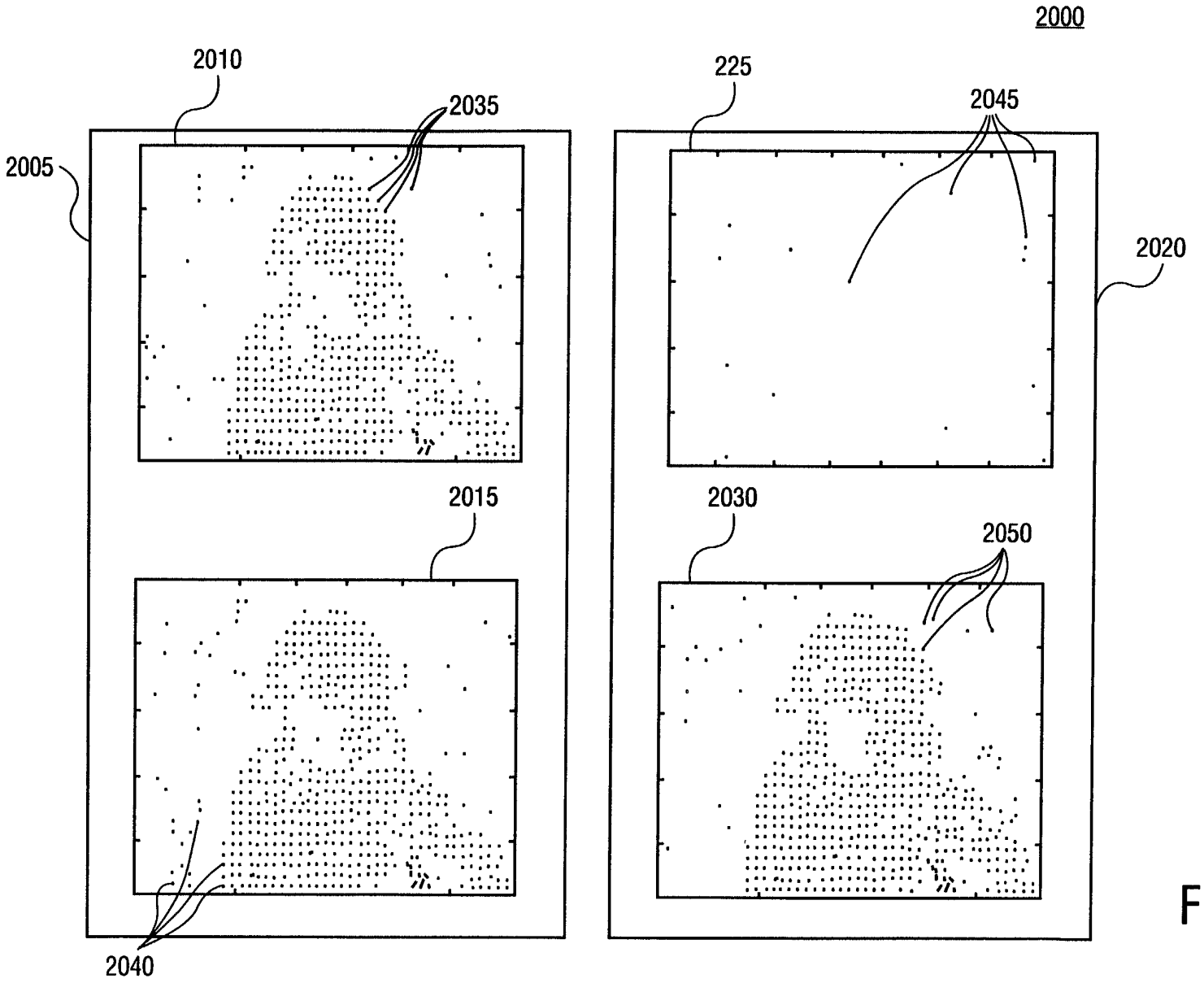

FIG. 20

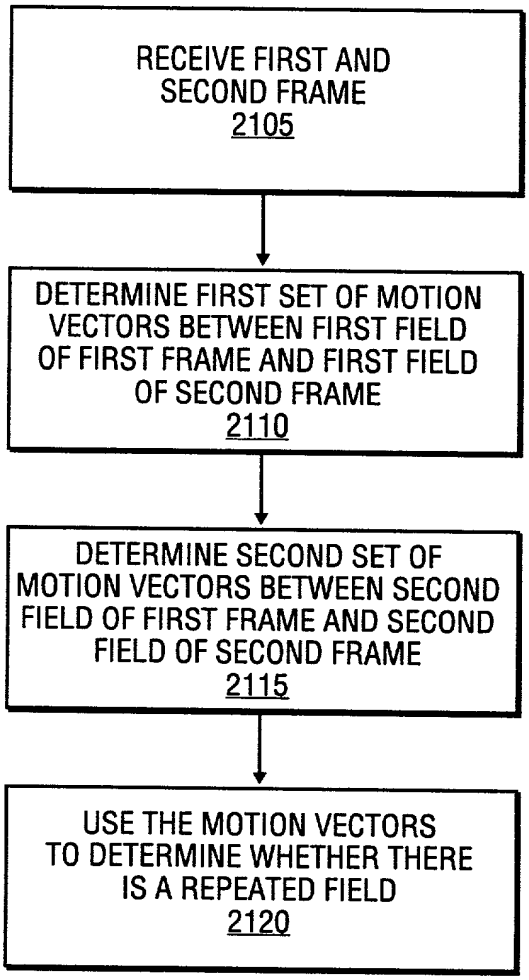
RECEIVE FIRST AND SECOND FRAME
2105
DETERMINE FIRST SET OF MOTION VECTORS BETWEEN FIRST FIELD OF FIRST FRAME AND FIRST FIELD OF SECOND FRAME
2110
DETERMINE SECOND SET OF MOTION VECTORS BETWEEN SECOND FIELD OF FIRST FRAME AND SECOND FIELD OF SECOND FRAME
2115
USE THE MOTION VECTORS TO DETERMINE WHETHER THERE IS A REPEATED FIELD
2120

FIG. 21

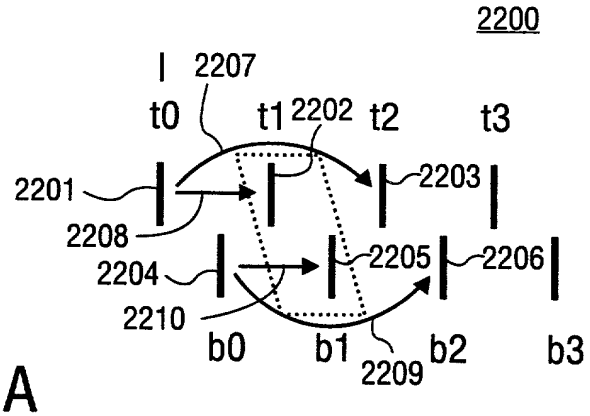

FIG. 22A

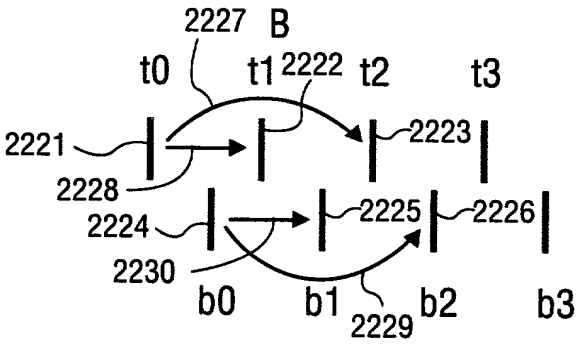

FIG. 22B

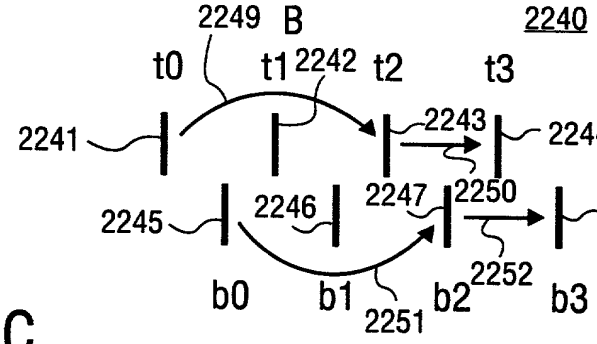

FIG. 22C

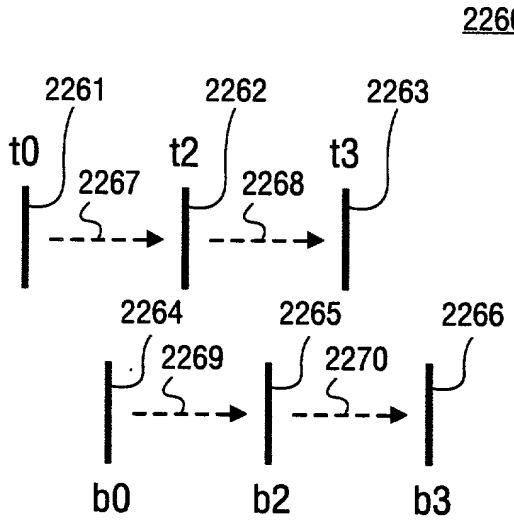

FIG. 22D

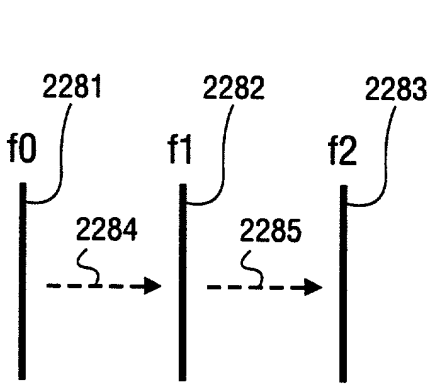

FIG. 22E

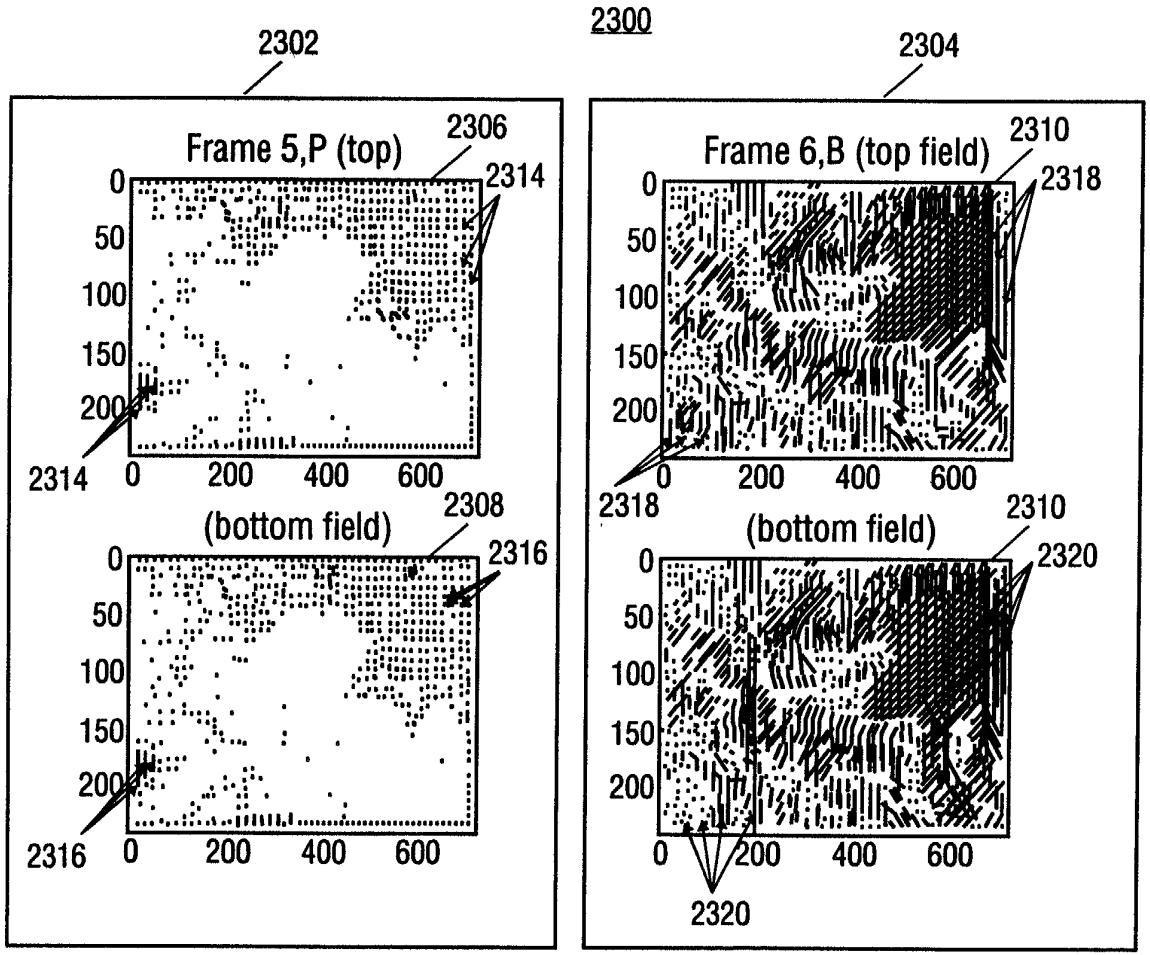
2300
2302
2304
Frame 5,P (top)
2306
2314
(bottom field)
2308
2316
Frame 6,B (top field)
2310
2318
(bottom field)
2310
2320
0
50
100
150
200
0
200
400
600

FIG. 23

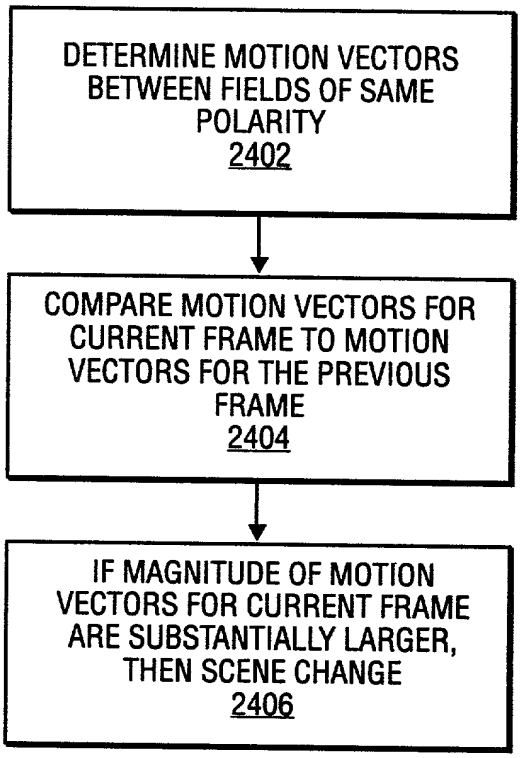
DETERMINE MOTION VECTORS BETWEEN FIELDS OF SAME POLARITY
2402
COMPARE MOTION VECTORS FOR CURRENT FRAME TO MOTION VECTORS FOR THE PREVIOUS FRAME
2404
IF MAGNITUDE OF MOTION VECTORS FOR CURRENT FRAME ARE SUBSTANTIALLY LARGER, THEN SCENE CHANGE
2406

FIG. 24